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Fundamentals of rotating fluidized beds and application to particle separation

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Driving Innovation ♦ Delivering Results

Fundamentals of rotating fluidized beds and application to particle separation

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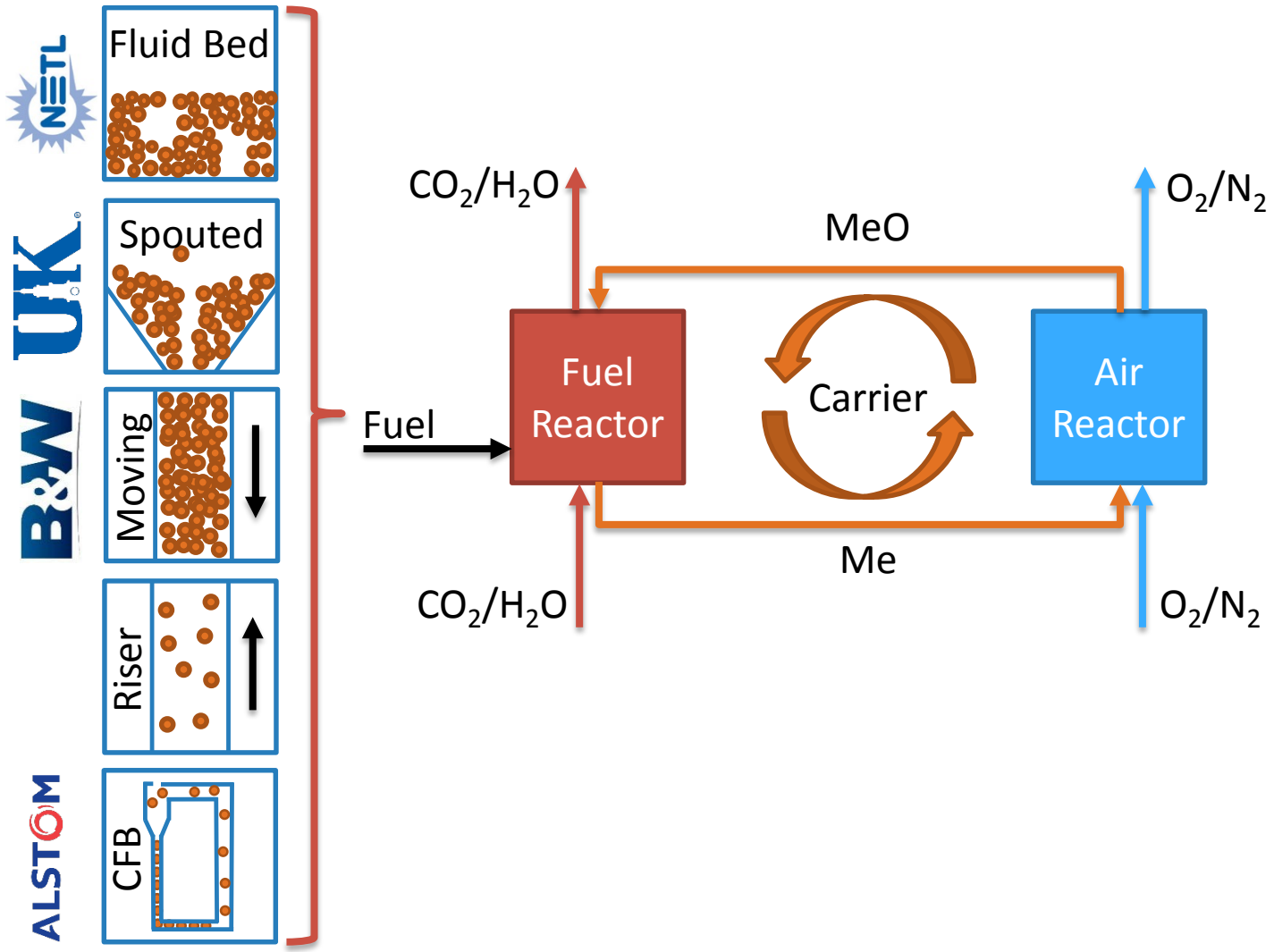
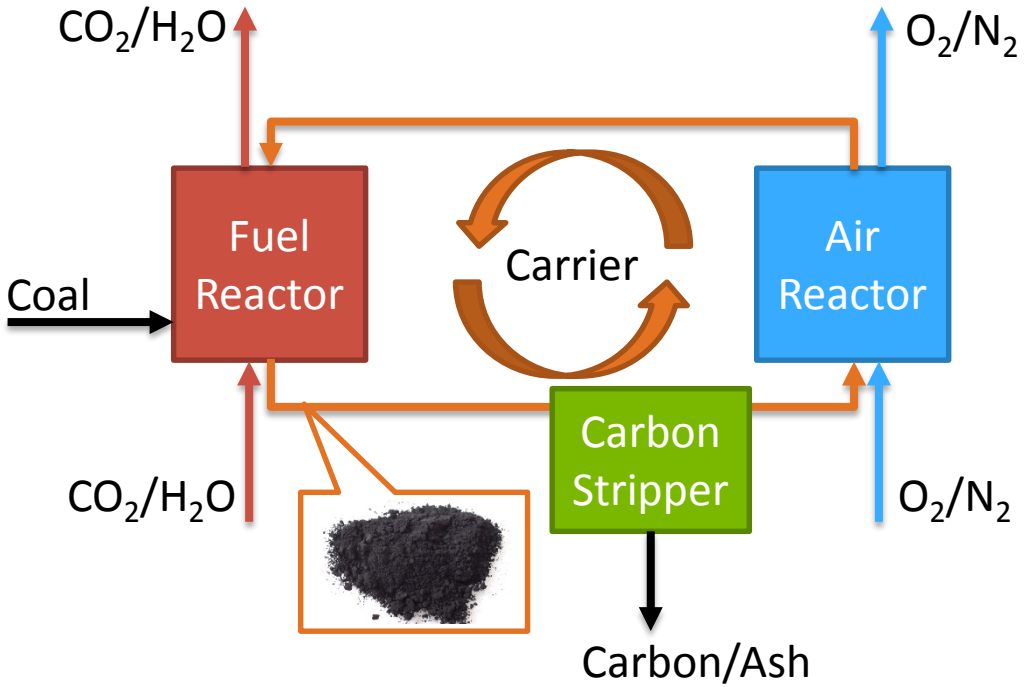
U.S. DEPARTMENT OF ENERGY | National Energy Technology Laboratory

Typical Chemical Looping Process

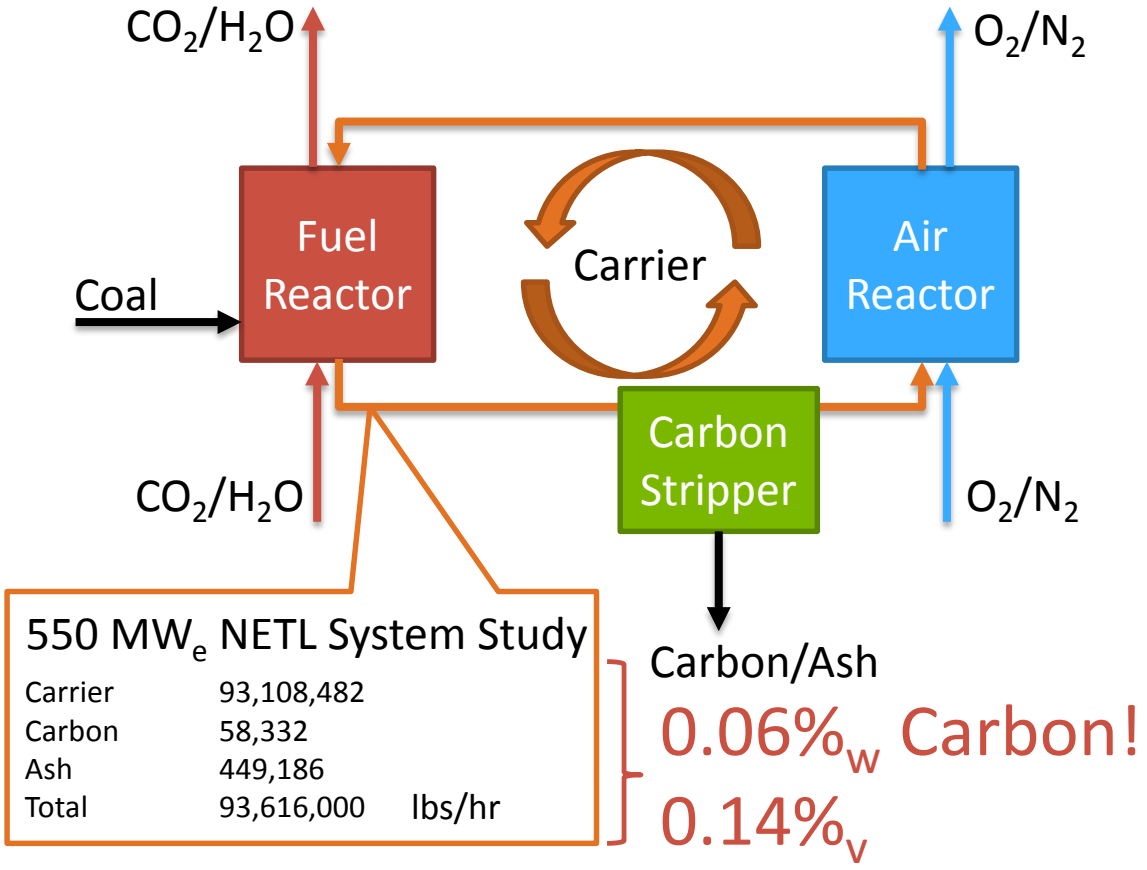


Fluid Bed
Spouted
Moving
Riser
CFB

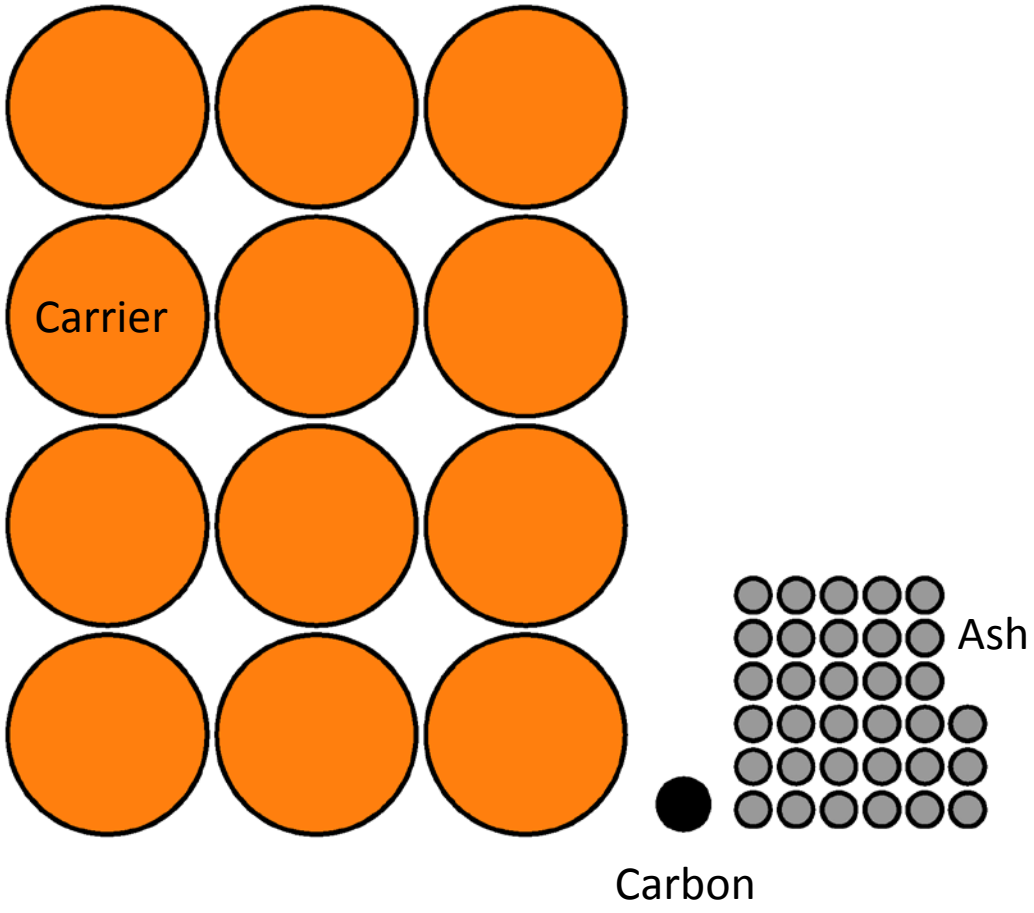
The Problem: Solid Fuels



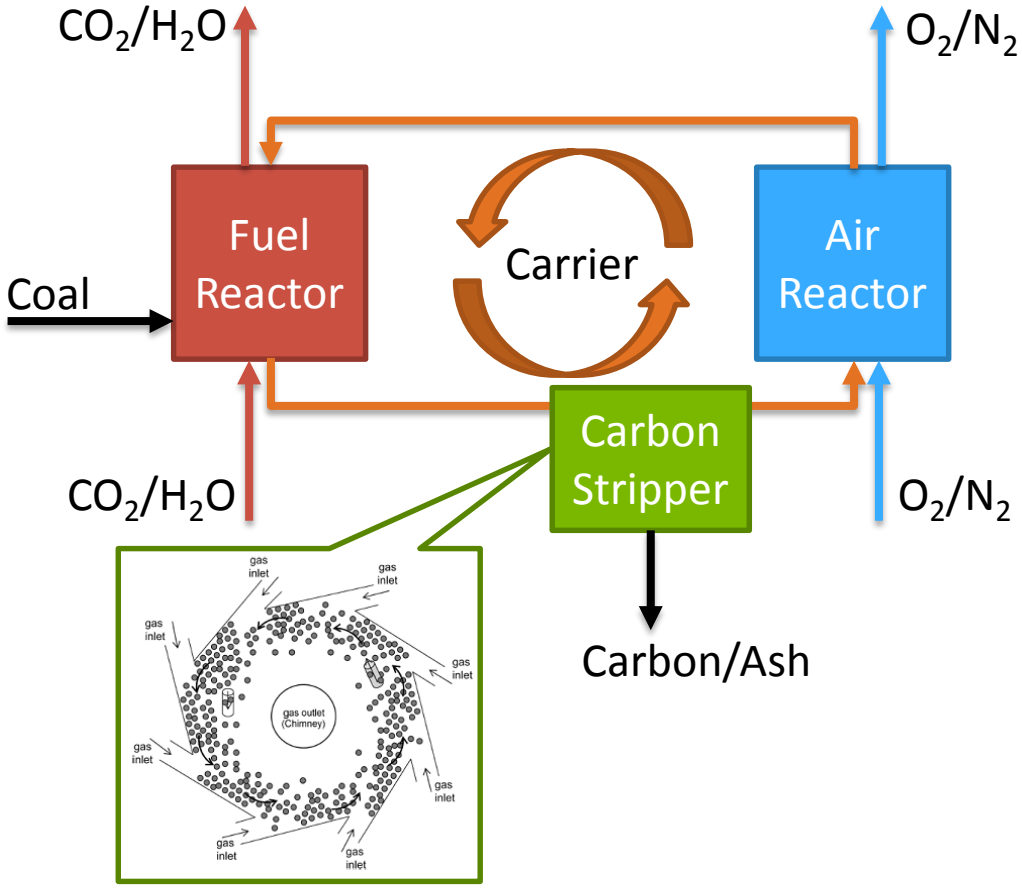
Let's put some numbers on it!



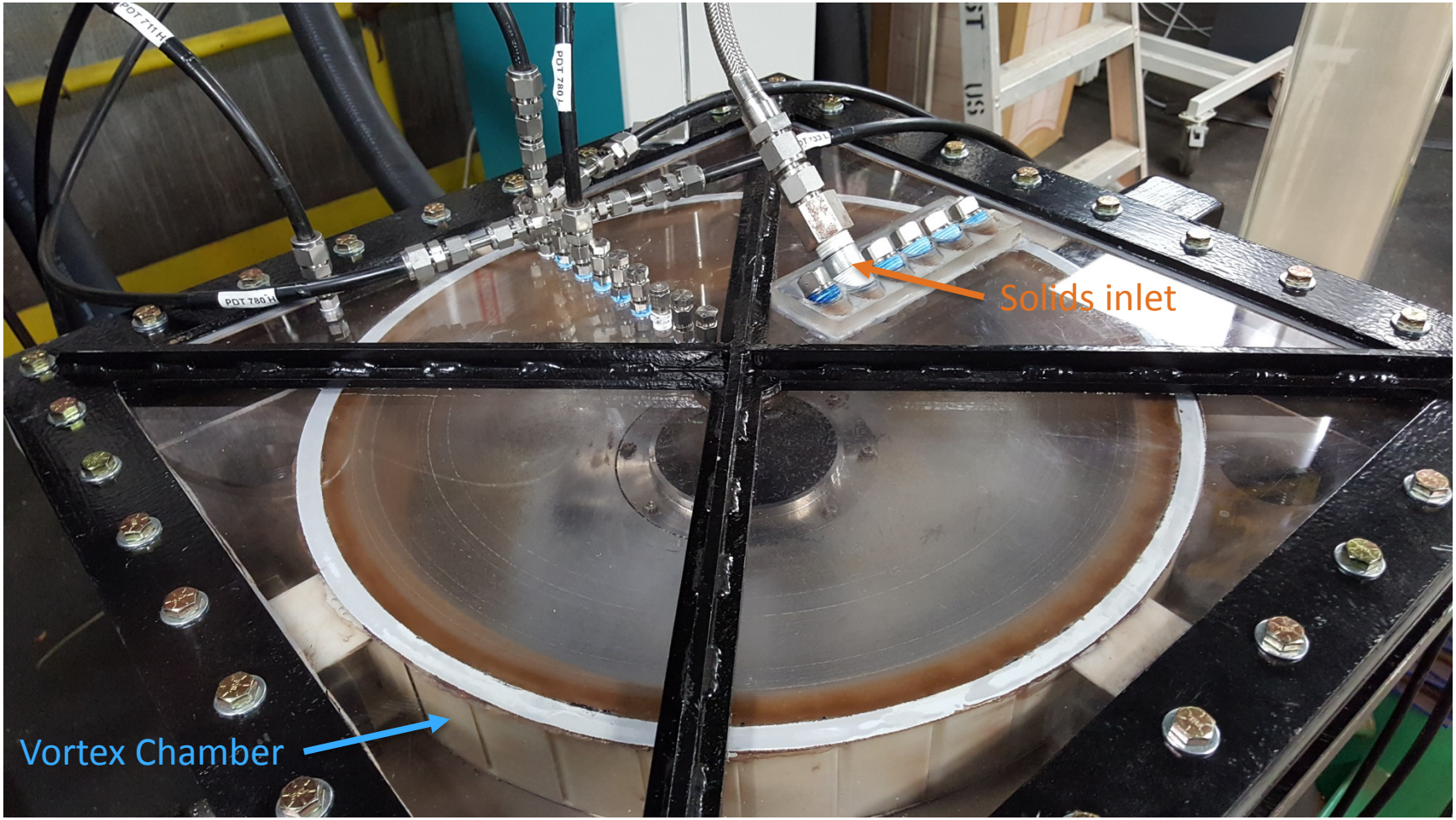
Lets put it into perspective



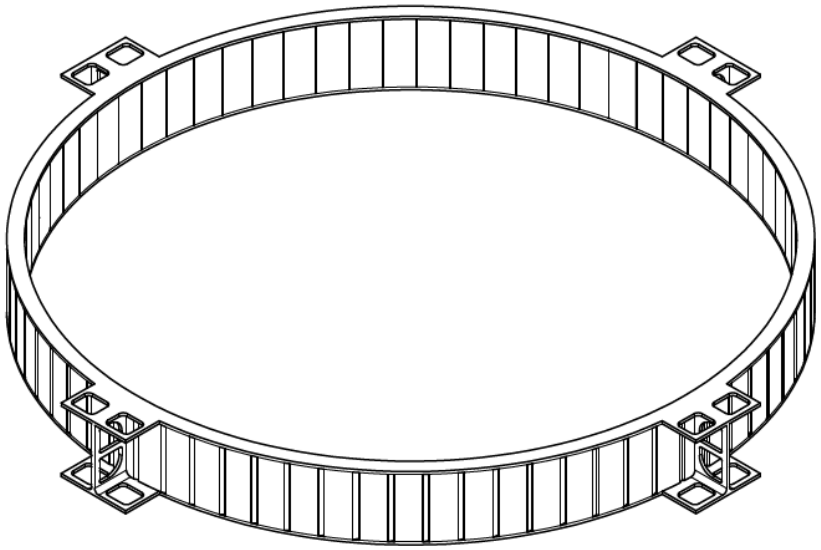
Rotating Fluid Bed as a Separator?

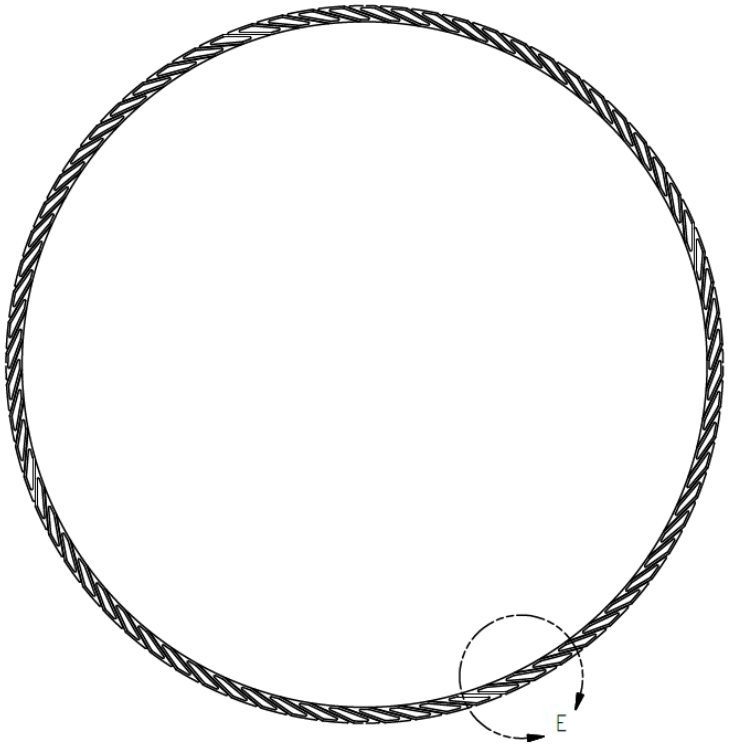


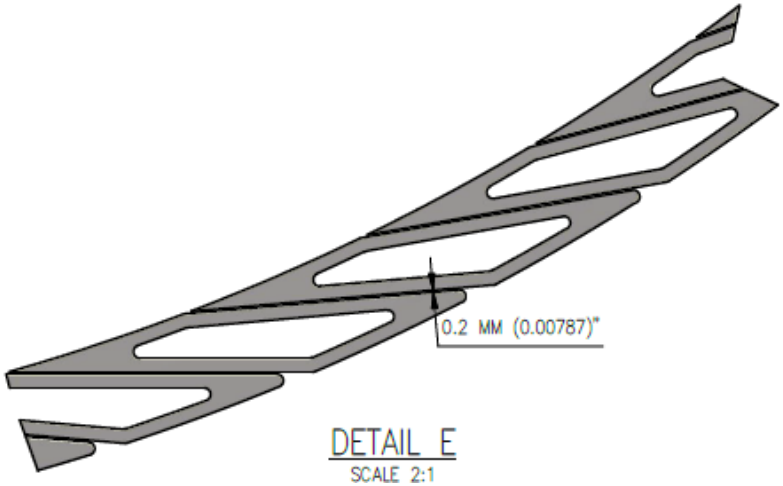
Experiment



3D printed vortex chamber



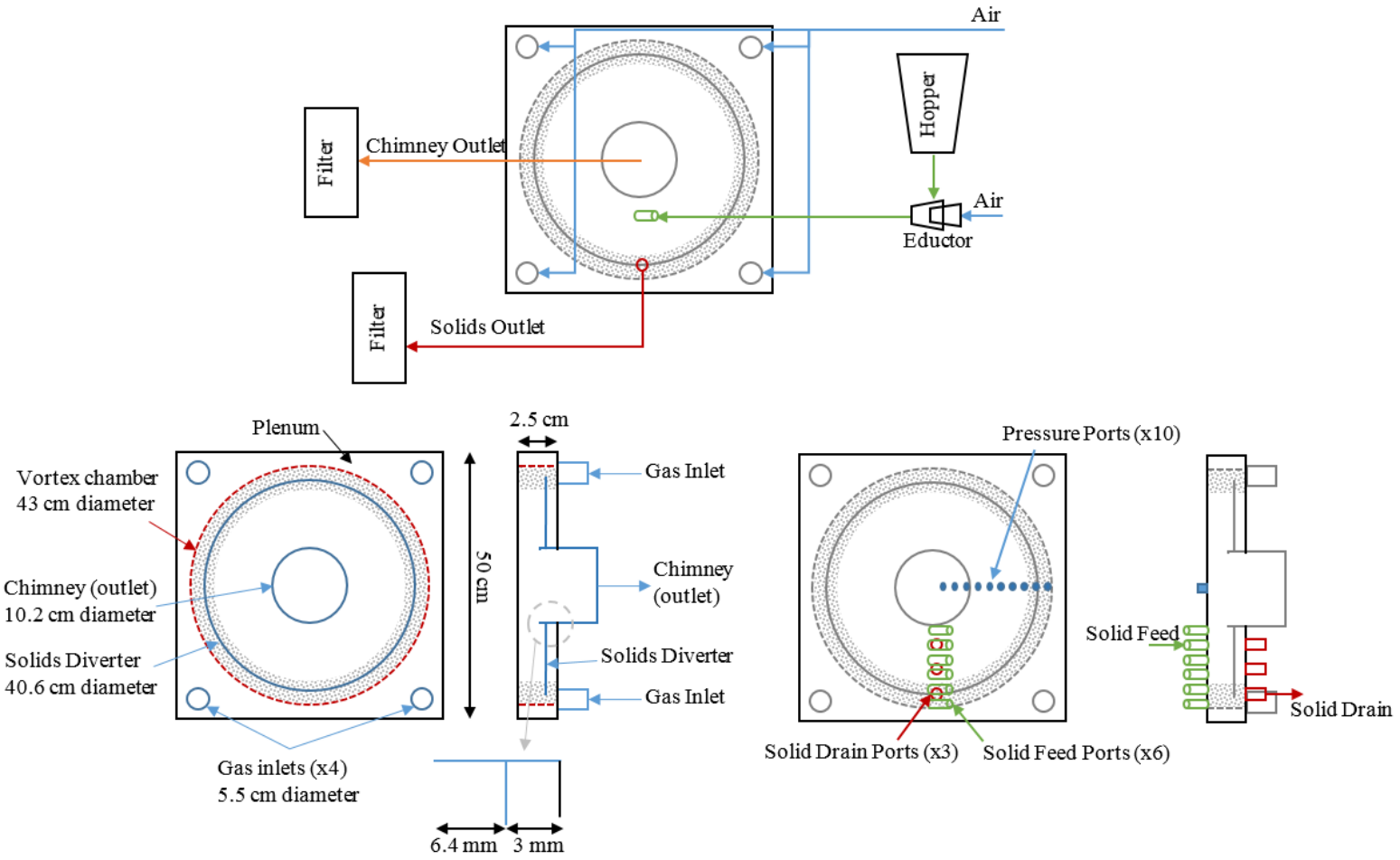




38, 0.381mm slots
25 cm thick
12G – 59G

3D printed vortex chamber

System Layout



Solid-Solid Separation

	density	d_{SMD}	d_{50}	sphericity	U_{mf}	particle mass
Material	g/cm^3	µm	µm		cm/s	mg
High Density Polyethylene	0.86	871	885	0.92	17.4	0.312
Glass Beads	2.51	329	333	0.92	9.47	0.049
Cork	0.19	797	835	0.8	9.37	0.058

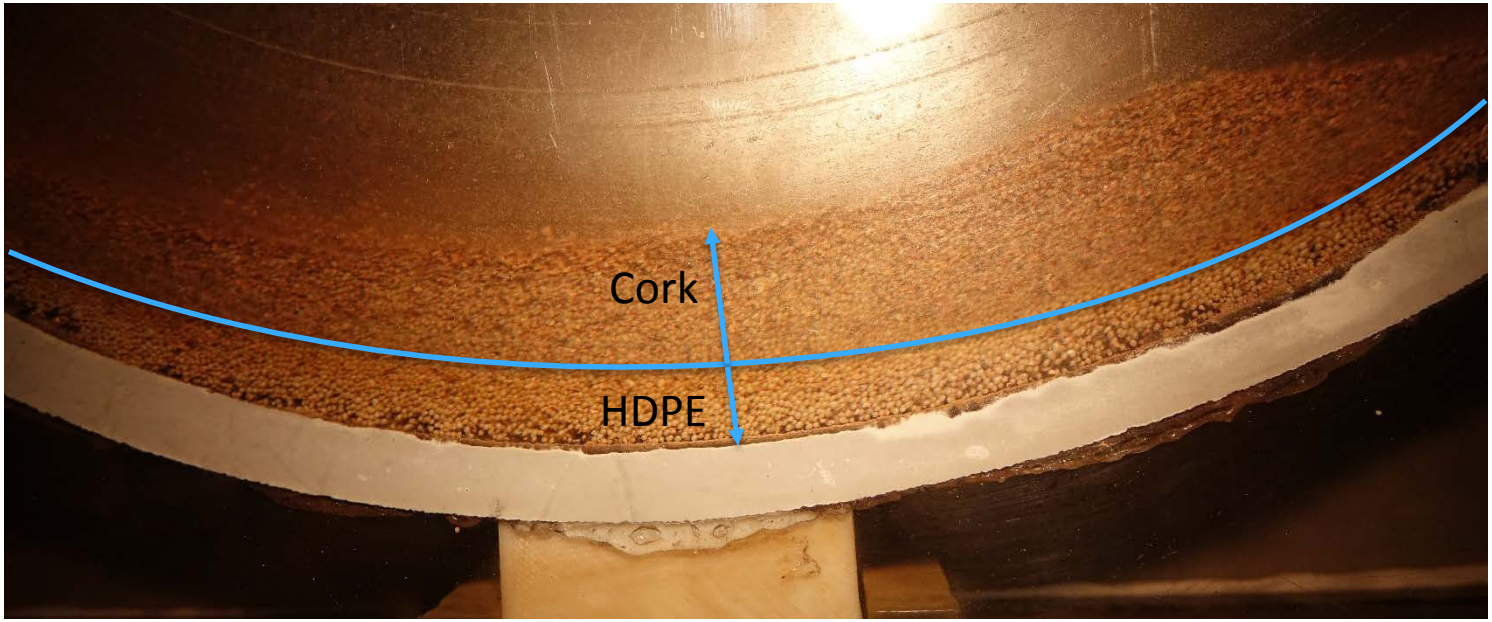
Centrifugal Force:

- Particle mass dependent
- Force directed radially outward

Drag Force:

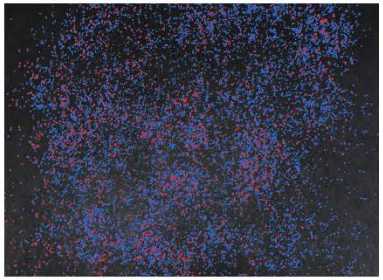
- Particle size dependent
- Force directed radially inward

Separated solids!



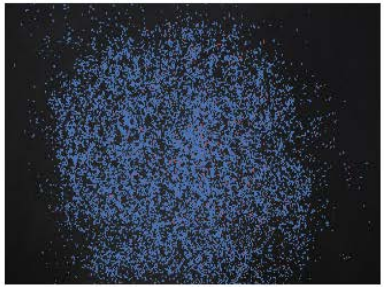
HDPE and Cork Separation

Mixture feed at inlet

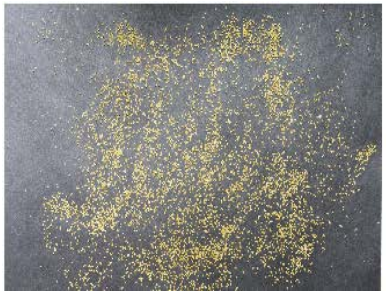


20% HDPE by particle count

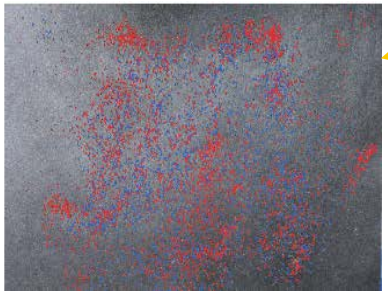
Mixture collected at chimney exit



98% cork by particle count



Mixture from solids drain exit

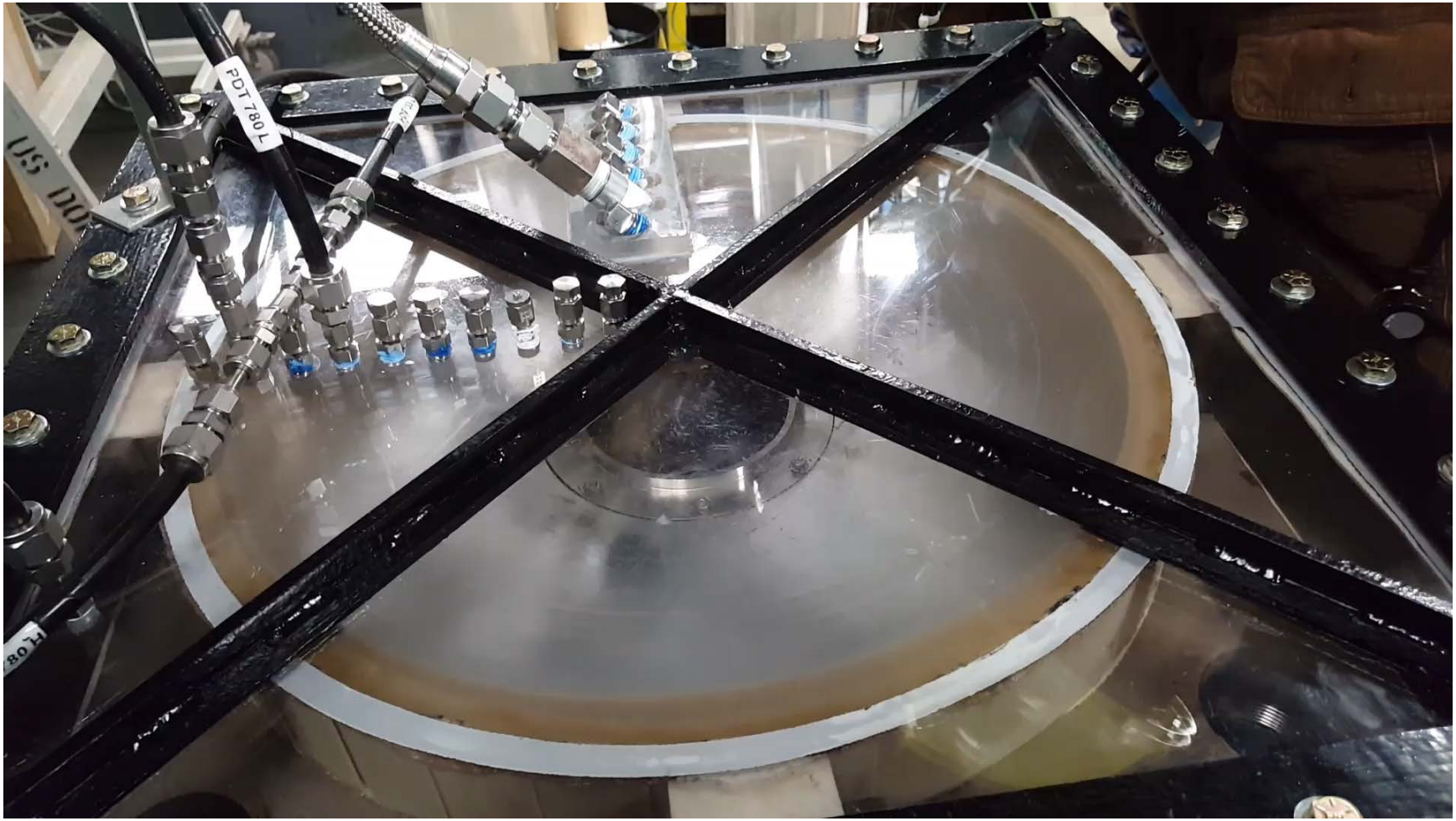


55% HDPE by particle count

*Glass Beads and HDPE did not separate

Slugging

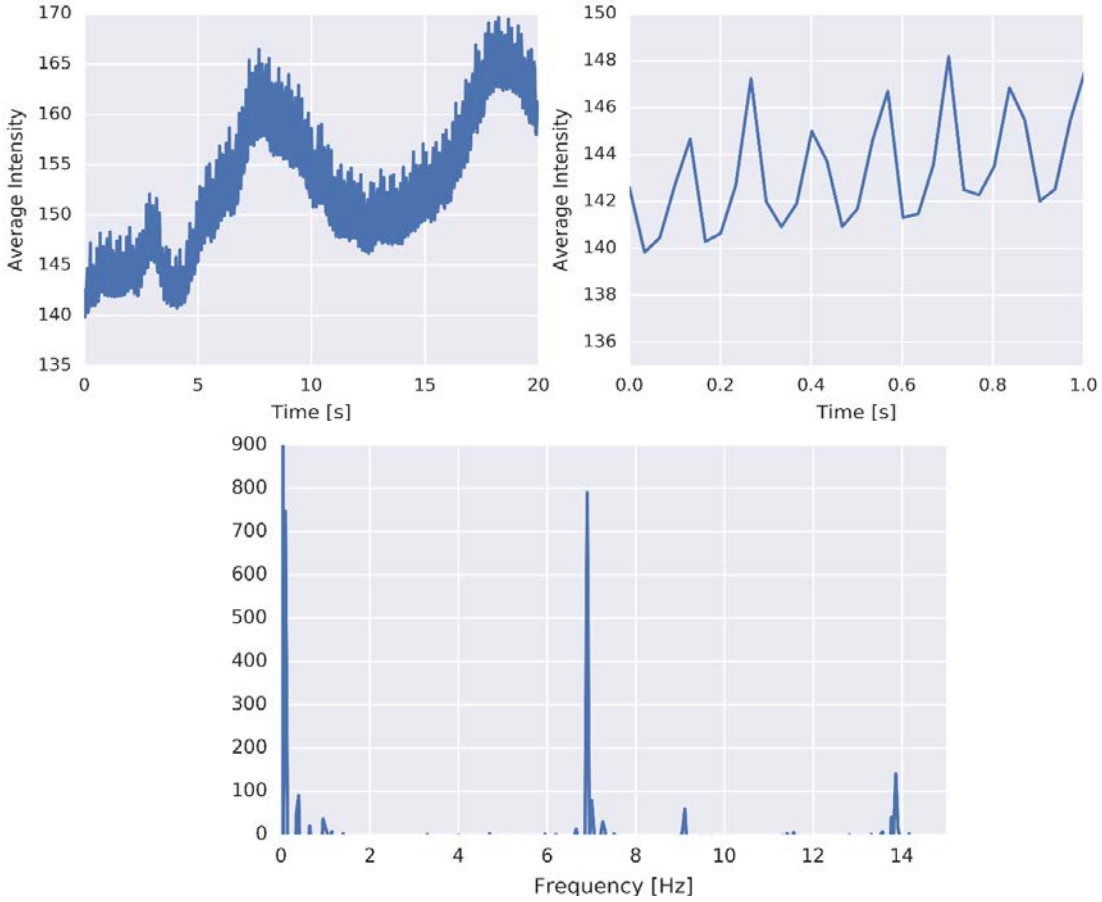
Video



Video of slugging

Particle Velocity

High Speed Video Analysis



Tangential velocity of 9.4m/s at a radius of 21.5cm; 45g

Drag vs Centrifugal Forces

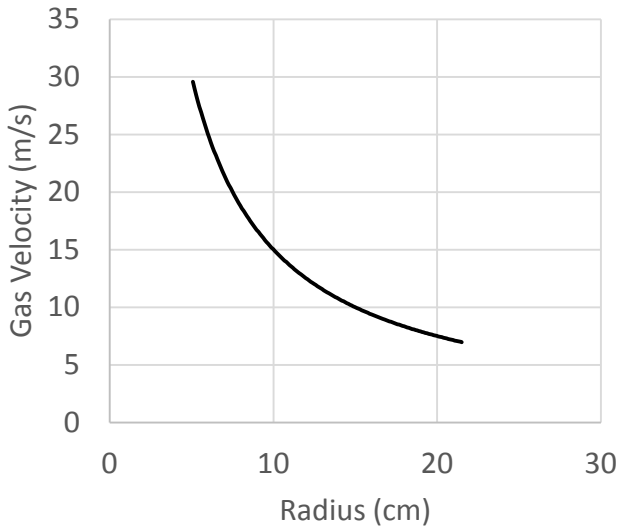
Radial Gas Velocity:

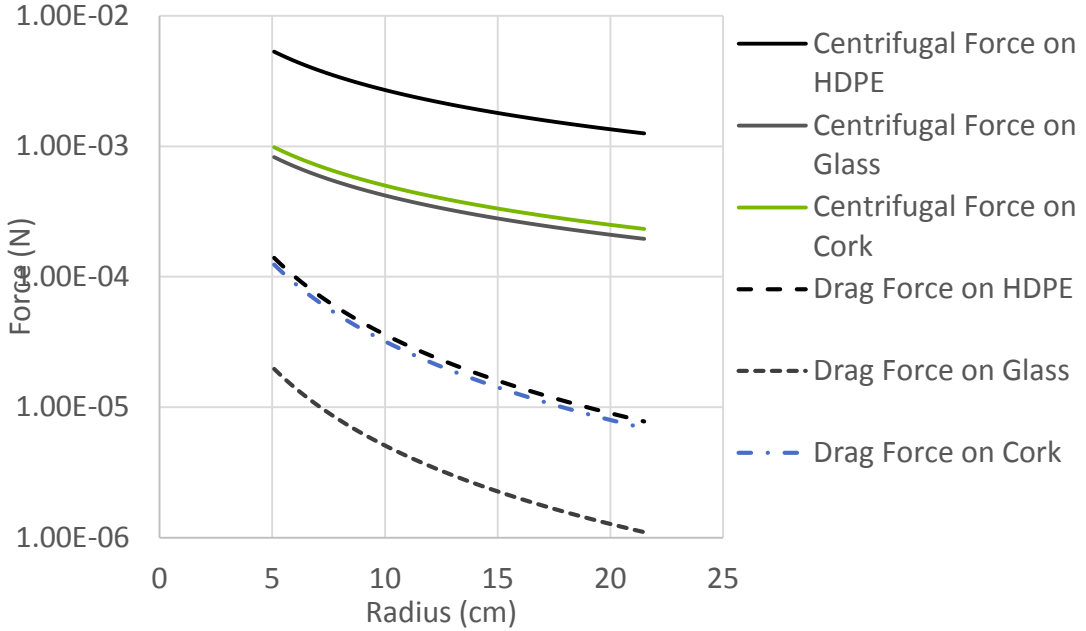
Air volumetric flow rate 30,000 SCFH

or

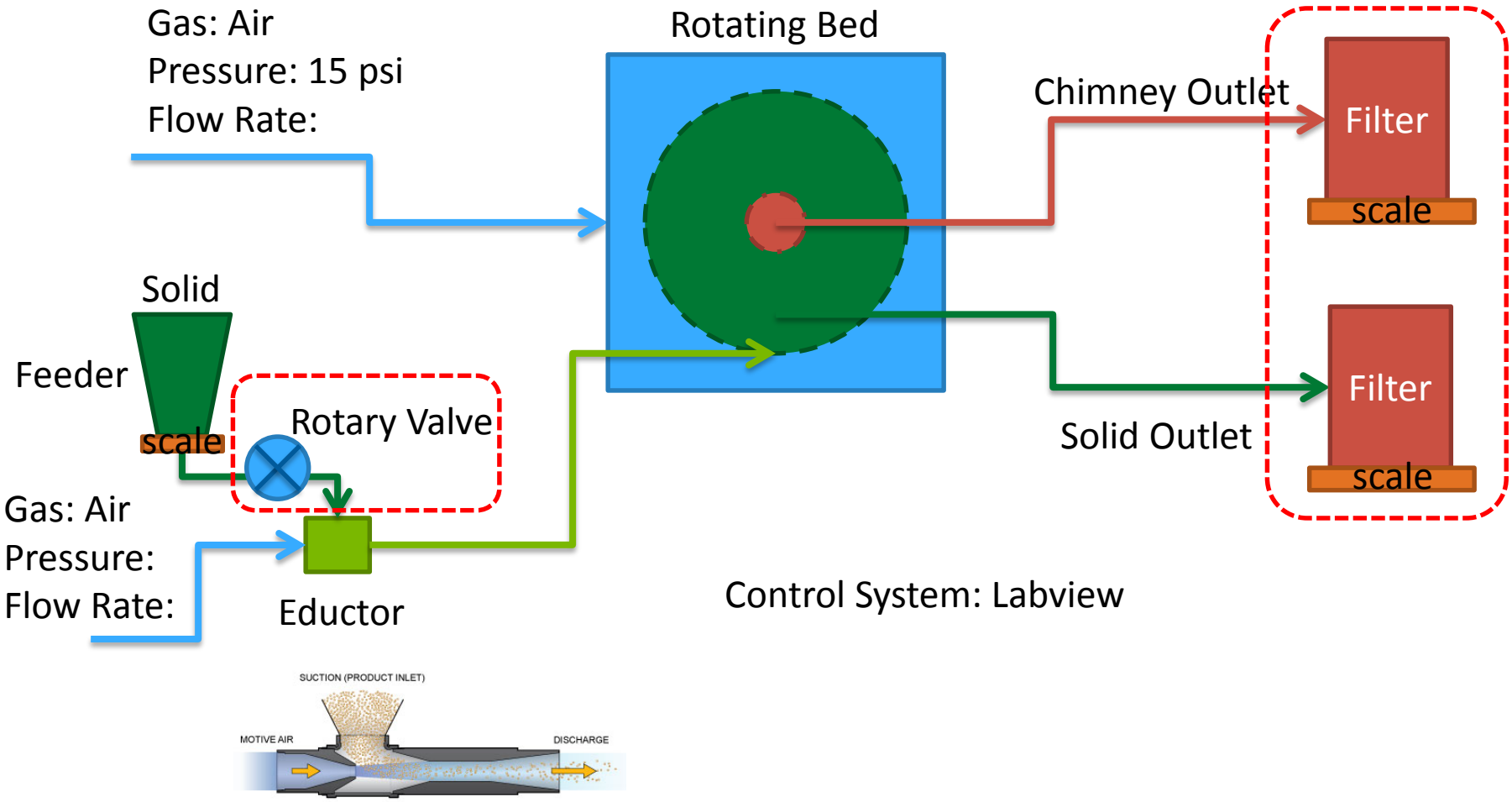
236,000 cc/s

$$F_{c,p} = \frac{m_p v_{t,p}^2}{r} \qquad F_{d,p} = \frac{1}{2}\rho_g v_{r,g}^2 C_D A_p$$





Continued Work



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